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THE POST-FLEDGING DEPENDENCE PERIOD OF THE BLACK-SHOULDERED KITE (*Elanus caeruleus*)

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ABSTRACT.—The post-fledging dependence period was studied in four broods (10 fledglings) of Black-shouldered Kites (*Elanus caeruleus*) in central Spain, and lasted around 34 d. In the two pairs most closely studied, the adult female abandoned the family group in the first two wk after fledging and the male continued alone caring for the offspring. Initial prey transfers from adult to fledglings were on perches but changed gradually to aerial transfers. Fledglings of one family group moved with the male to a hunting area 2 km from the nesting area. Fledglings gradually improved their flying skills, increasing the time spent flying and the use of gliding and hovering flights relative to exclusively flapping flights. They showed behaviors that were considered as play and gradually developed their hunting skills, catching small mammals before becoming independent. As the fledglings started hunting by themselves, the male decreased the time spent hunting and the number of prey given to them. No aggressive actions by the male toward its offspring were observed at the end of the post-fledging dependence period.

El periodo de emancipación en el Elanio Azul (*Elanus caeruleus*)

RESUMEN.—Se estudió el periodo de emancipación en cuatro polladas (10 jóvenes) de Elanio Azul (*Elanus caeruleus*) en España central, y éste duró alrededor de 34 días. En las dos parejas estudiadas con más detalle, la hembra adulta abandonó el grupo familiar en las dos primeras semanas del periodo de emancipación, y el macho continuó solo cuidando de la descendencia. Inicialmente las transferencias de presas entre adultos y jóvenes tenían lugar en un posadero, cambiando gradualmente hacia transferencias en vuelo. Los jóvenes de uno de los grupos familiares se desplazaron junto con el macho a un cazadero a 2 km de distancia, abandonando la zona del nido. Los jóvenes mejoraron gradualmente su capacidad de vuelo, incrementando el tiempo pasado volando y el empleo de vuelos planeados y cernidos en detrimento de vuelos exclusivamente aleteados. Los jóvenes mostraron pautas de comportamiento que fueron consideradas como juegos y maduraron gradualmente las técnicas de caza, capturando micromamíferos por sí solos antes de independizarse. A medida que los jóvenes pasaban más tiempo cazando disminuyó el tiempo que el macho dedicaba a esta actividad y se redujeron las transferencias de presas del macho a los jóvenes. No se observaron agresiones por parte del macho hacia su descendencia al final del periodo de emancipación.

[Traducción Autor]

There is very little published information on the post-fledging dependence period of the Black-shouldered Kite (*Elanus caeruleus*). Neither Brown and Amadon (1968) nor Cramp and Simmons (1980) give any information on this period. However, Mendelsohn (1981) observed the post-fledging of 10 Black-shouldered Kite fledglings in South Africa, provided some behavioral observations, and found a mean duration of post-fledging dependency of 82 d (cited also by Newton 1979).

This study describes the post-fledging dependence period, flight progression and maturation of hunting behavior in four broods of Black-shouldered Kites in central Spain.

STUDY AREA AND METHODS

In the spring of 1989, four family groups (pairs 1–4, brood-size four, three, one and two chicks, respectively) were studied near Madrigalejo in the Guadiana River Basin (39°4′N, 5°40′W), central Spain. This is an area of flat to gently undulating topography with irrigated and cereal crops. Black-shouldered Kites nested on evergreen oaks (*Quercus rotundifolia*) that were scattered in the cereal fields.

Observations started on 21 May, when the first chicks fledged—defined here as the age when the first flight was observed—and ended on 12 July, when most fledglings seemed to have disappeared from the area and the three remaining (pair 2) were no longer being fed by the adults. All four family groups were checked regularly, with short

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visits at sunrise or sunset, to determine if fledglings and adults were still present at the nesting area (every 1–5 d from 21 May to 10 June, and at least once every 10 d from 10 June to 12 July, totaling 10–17 visits on different days per family group).

Two dawn-to-dusk (0500–1930 GMT) observations of pair 1 and one observation from 1300–2000 GMT of pair 2 showed that 80% of the activity of fledglings took place before 0830 GMT in the mornings and after 1600 GMT in the evening, and that hunting and feeding by adults were even more concentrated at dawn and dusk. Accordingly, I decided to continue with behavioral observations of the family groups only from 0430–0830 and from 1600–2000 GMT. A total of 146 hr of behavioral observations were made (66, 64, 8 and 8 hr in pairs 1–4, respectively). Pairs 1 and 2 were more intensively observed because the topography and tree density facilitated the observation of individuals.

All chicks were individually marked 10–15 d before fledging by feather dying (Young and Kochert 1987). Five fledglings (one in pairs 1, 3 and 4 and two in pair 2) were also equipped with radiotransmitters attached with a backpack harness (Beske 1978; weight with harness 9 g = 3% of body mass). In the two family groups observed more intensively, two adults were marked by feather dying before observations began, the female of pair 1 and the male of pair 2.

Observations were initially performed from inside a vehicle parked 300 m from the nest by one observer with 10× binoculars and a 60–80× field scope. Once fledglings started wandering they were followed by the observer from a distance of 100–1500 m.

Numerous behaviors related to the learning of hunting skills were observed in the fledglings during the post-fledging period. Following Fagen (1976) and Ficken (1977), some behaviors were considered as play because they were different from the habitual adult hunting behavior. They were behavioral sequences that were used by fledglings out of context, or involved repetition of incomplete behavioral sequences. Other hunting behaviors without the previous characteristics were considered as gradual maturation of hunting skills.

RESULTS AND DISCUSSION

Fledging Age and Duration of the Post-Fledging Dependence Period. Chicks fledged 34–41 d after hatching, a similar age to that reported by others for the Black-shouldered Kite (e.g., Cramp and Simmons 1980). On pair 2, where I saw the first flight of all chicks, there was an 8-d difference in fledging date between the first and the last chick in the brood.

At the two broods less intensively watched, the fledglings were last seen 25 d (pair 3) and 16 d (pair 4) after fledging. One fledgling in each brood was equipped with a radiotransmitter, but the signals could not be located thereafter in the vicinity of the nesting area. Nonetheless, I cannot disregard the possibility that the fledglings had moved with one or both adults to a different hunting area far from the nest because, due to interference, the signal of the radiotransmitters was usually not received from more than 1–2 km. At the two broods more intensively observed, the male stopped feeding his offspring 30–39 d (pair 1) and 22–42 d after fledging (pair 2). Fledglings of both family groups were observed at the male hunting territory hunting independently before they dispersed. Based on the two more intensively observed broods, I estimated an average post-fledging duration of 34 d for the population in central Spain (39°N). This is less than half the dependence period observed by Mendelsohn (1981) at 25°S in South Africa (82 d), but follows the general tendency of shorter post-fledging periods at higher latitudes (Bustamante 1990).

One fledgling from brood 1 disappeared 9 d after fledging, and probably died before independence. Its siblings were fed by the male for at least 21 d more.

Feeding by Adults and Prey Transfers. In the two pairs with marked adults (pairs 1 and 2), both parents hunted (mainly rodents and small birds) and brought the prey to the young. The female usually brought the prey to the nest, both those caught by her and those caught by the male partner. In pair 2, the female hunted close to the nest and caught 19% of the prey she delivered to the nest while 35% were given to her by the male (N = 26 prey). The females of pairs 1 and 2 abandoned the family group long before the fledglings were independent (6 and 11 d after fledging, respectively) and the male continued alone feeding the fledglings (Fig. 1). Since adults were not marked in the other two family groups and observations were more difficult, it was not clear if one or both adults cared for the young before they all disappeared. Early female abandonment after fledging was also observed by Mendelsohn (1981) in the Black-shouldered Kite. Otherwise, it has only been recorded in the Snail Kite (*Rostrhamus sociabilis*), although males may also desert early in this species (Beissinger and Snyder 1987, Beissinger 1990).

Feeding frequency by pairs 1 and 2 increased slightly during the first two weeks after fledging and decreased thereafter (Fig. 1) as the fledglings were starting to hunt by themselves.

Initially, prey were brought by the parents to the nest. The nest was used as a feeding platform and as a roost by the fledglings, but soon it was replaced by other alternative perches (trees and fences). At one family group (pair 1) the fledglings followed the

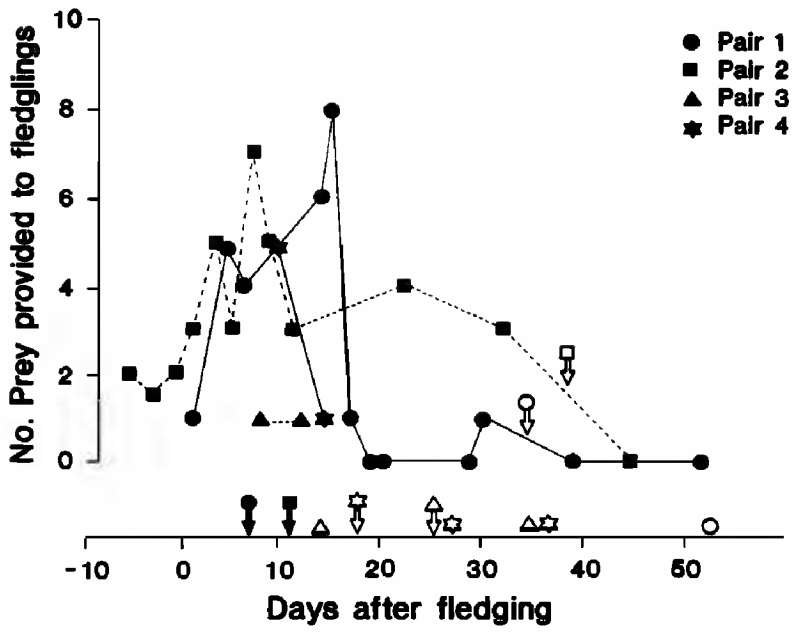

Figure 1. Number of prey brought to the fledglings in a 4-hr period at sunrise or sunset, or average when both were observed the same day. Male and female combined when both present. Solid arrows indicate the last day females of pair 1 and 2 were seen. Open arrows indicate the estimated time of independence (pairs 1 and 2) or the day fledglings were last seen (pairs 3 and 4). Open symbols indicate timing of other short visits to each nest site to check if birds were present.

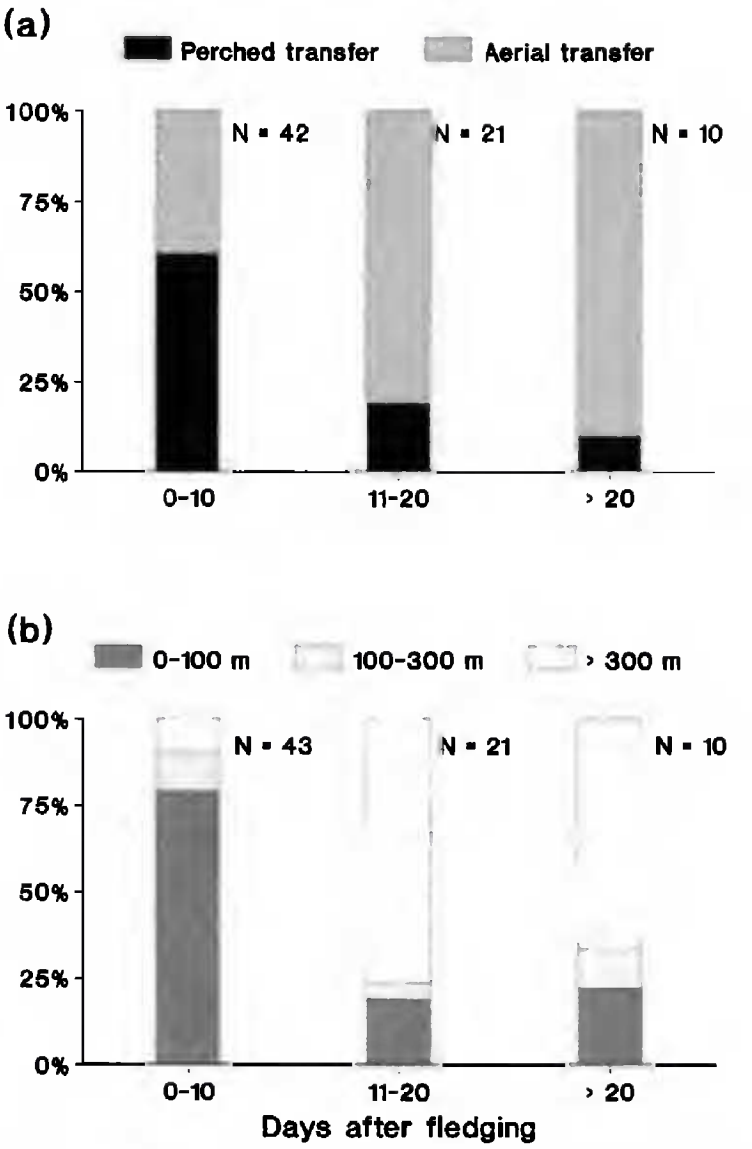

Figure 2. Change in prey transfers with days after fledging: (a) Percentage of perched and aerial transfers in relation to days after fledging. (b) Percentage of prey transfers at different distances from the nest in relation to days after fledging.

male to a hunting area 2 km away, and the nest was rarely used after that. A few days after first flights, fledglings tended to fly toward the adult coming with prey. During the first attempts, adults avoided approaching fledglings and brought the prey to the nest, especially if any of the chicks in the brood had not fledged yet. Once all siblings were on the wing, adults hovered and waited for the approach of fledglings. The first fledgling to reach the adult turned upside-down and removed the prey from the adult's talons in the air. As the fledglings improved their flight skills, this type of prey transfer almost replaced transfers on a perch (Fig. 2a). Prey transfers tended to take place farther from the nest as fledglings got older (Fig. 2b). Sometimes the prey fell to the ground during the transfer, and in most instances was retrieved by one of the fledglings.

Aerial prey transfers may be a way to practice the skills necessary for the capture of agile prey and have been recorded mainly in species feeding on birds and small mammals (e.g., *Accipiter* spp., Simmons 1984, Newton 1986, Palmer 1988; *Circus* spp., Snyder 1931, Benson 1958, Palmer 1988; *Falco* spp., Schuyl et al. 1936, Tinbergen 1940, Sherrod 1983). Also, it has been suggested that aerial prey transfers can be used by parents to test the flying proficiency of the fledglings and decide when to stop feeding them (Simmons 1984, Ferrer 1990).

Nest Defense by Adults. Adults behaved aggressively toward some species of raptors coming close to the nest or the fledglings. In those instances, one or both adults chased away the intruder, diving repeatedly until it left the area. Montagu's Harrier (*Circus pygargus*) was the most frequent intruder in the nesting areas ($N = 82$), but was never chased away by the adults even when coming very close to the nest or fledglings. The Common Buzzard (*Buteo buteo*) was a frequent intruder and was chased on 77% of the occasions it was observed close to a breeding territory ($N = 22$). Black Kites (*Milvus migrans*) and other Black-shouldered Kites, relatively infrequent intruders, were also chased away (one of two intrusions and two of six intrusions, respectively). The Common Buzzard was probably the only spe-

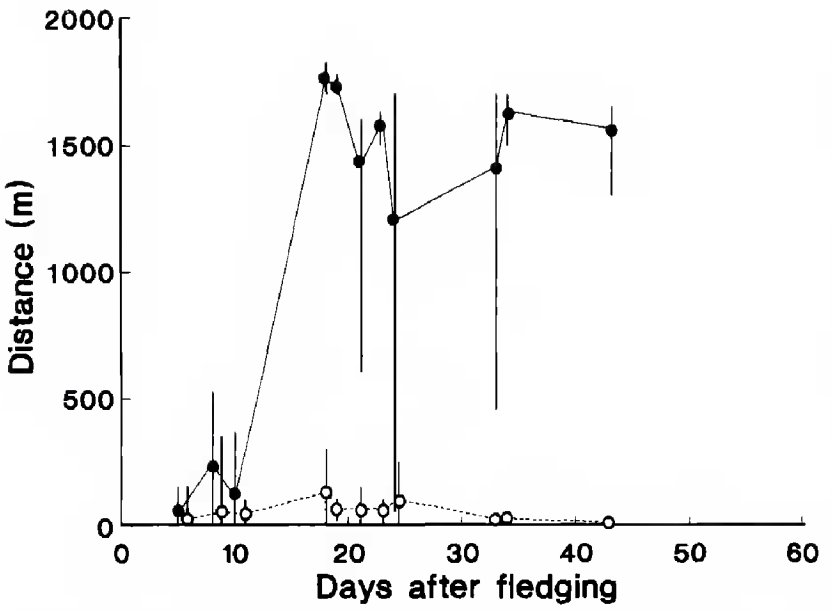

Figure 3. Distance from the nest, mean (solid circle) and range, and distance among fledglings, mean (open circle) and range, in pair 1 in relation to days after fledging. The average distance from the nest and the average distance among fledglings were calculated for each day at ½ hr intervals.

cies of raptor observed in the area that posed a certain risk of predation on inexperienced Black-shouldered Kite fledglings. Although there are no records of the Black-shouldered Kite as prey of the Common Buzzard, birds larger than kites have been frequently recorded in the diet of Common Buzzards (Cramp and Simmons 1980). Thus, it was not strange that adult kites behaved aggressively toward the buzzards. The Black-shouldered Kite excludes other conspecifics from its hunting territory (Mendelsohn 1981), so aggression toward other Black-shouldered Kites could be expected.

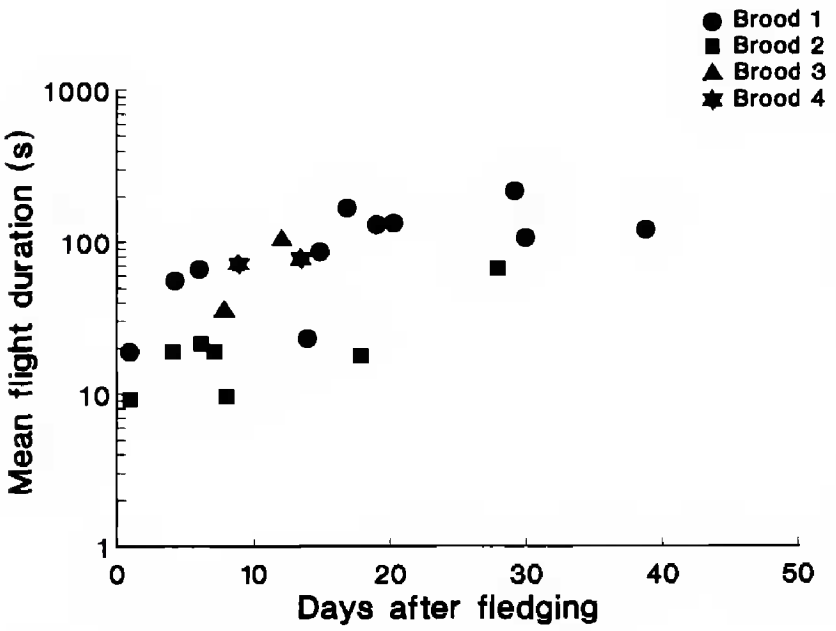

Figure 4. Change in mean flight duration (on a log scale) with days after fledging. The mean value for all siblings in multiple broods is represented. For pair 2, days after fledging is the mean value for the chicks that had already fledged on that date.

Social Interactions. Family groups, with the exception of the adult female, maintained a strong cohesion during the post-fledging dependence period. Fledglings in most instances could see the male hunting from their perch. In the only pair in which the male used to hunt far from the nest (pair 1), the fledglings followed the male to the hunting area and perched there. However, the fledglings still remained close to each other (Fig. 3). Mendelsohn (1981) also noted that Black-shouldered Kite fledglings followed the male when hunting, but in most species of raptors fledglings do not follow the adults far from the nest (e.g., Matray 1974, Bustamante and Hiraldo 1989, Bustamante in press, but see Johnson 1986).

Although siblings were sometimes observed chasing each other (eight different instances), they never disputed prey among themselves and frequently chose to perch close to each other without any aggression. Fledglings also chased Montagu's Harriers (three different kite fledglings in three different instances), the most common raptor in the area. In contrast, harriers were never chased by the adult kites. No aggressive actions from the male toward its offspring were observed at the end of the post-fledging period.

Development of Flight Skills. The first flights of fledglings were short flapping flights between perches. Daily number of flights increased with age, although not significantly, during the post-fledging ($r_S = 0.28$, $N = 22$, $P = 0.2$). Other flight variables like total time spent flying ($r_S = 0.63$, $N = 22$, $P = 0.004$) or mean flight duration ($r_S = 0.71$, $N = 22$, $P = 0.001$) (Fig. 4) had a significant increase with age. The first hovering flight was observed a mean of 8.9 d (SD = 2.9, $N = 8$) after fledging. Fledglings gradually increased the use of gliding and hovering compared to exclusively flapping flights (Fig. 5), but no soaring flights were observed.

Development of Hunting Behavior. Two play behaviors were frequently observed: (1) *Mock pouncing.* Fledglings jumped repeatedly from a low perch (e.g., a fence) to the ground with extended talons. The behavior was comparable to perch hunting but the fledglings never captured prey or any other object, and the behavior was repeated on the same spot several times in a row. This behavior was recorded for the first time 3 d after fledging. It was seen in 11 different instances and at least in three out of the

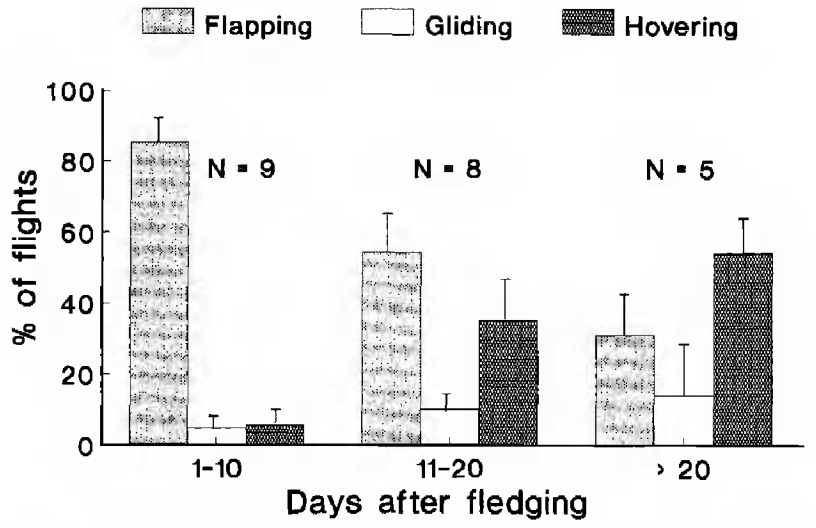

Figure 5. Percentage of different flight types in relation to days after fledging. Mean and SE of daily percentage of flights in each category. N = number of days.

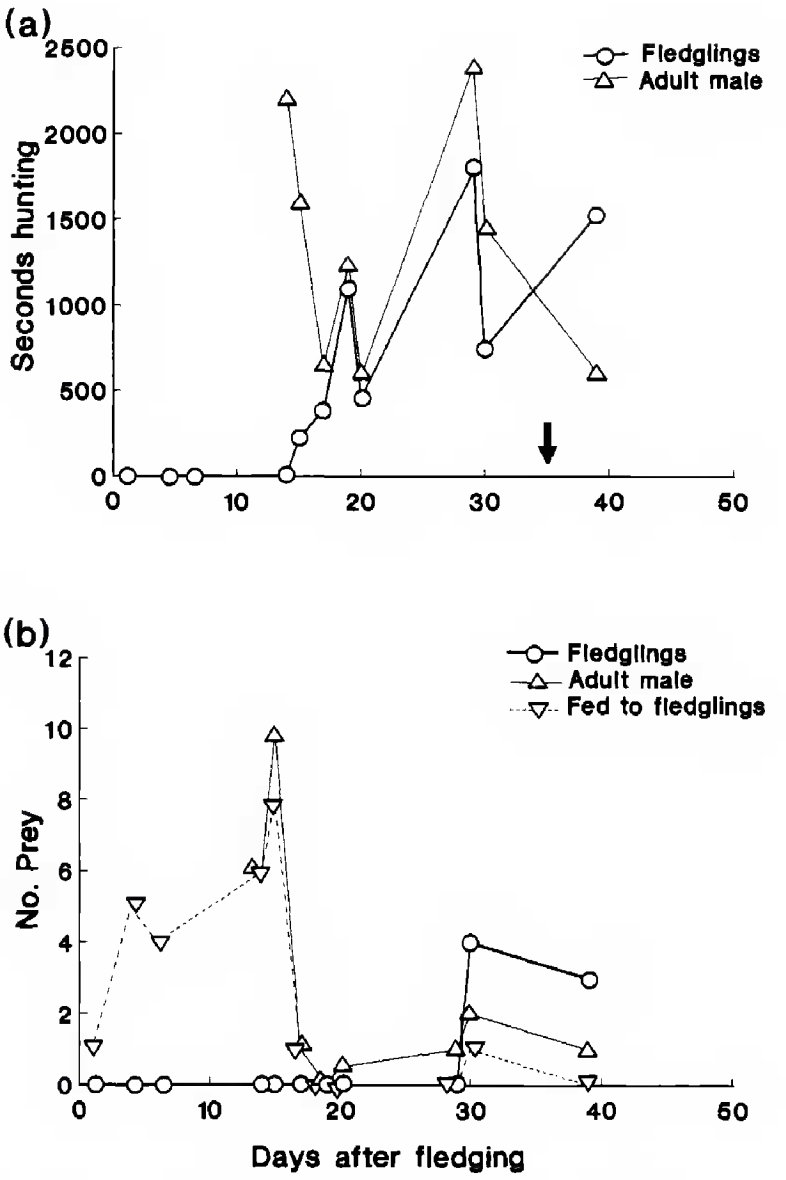

Figure 6. (a) Mean time devoted to hunting (seconds hunting in a 4-hr period), by the fledglings and the adult male of pair 1, in relation to days after fledging. All three fledglings pooled. (b) Number of prey caught by the fledglings, number caught by the adult male, and number delivered by the male to the fledglings in relation to days after fledging, in pair 1 (average number when both sunrise and sunset 4-hr periods were observed on the same day). The arrow indicates estimated age of independence of the fledglings.

10 fledglings. (2) *Void hunting attempts.* These were flight behaviors that included movements related to prey capture, but in a different context. They were also observed in fledglings that had already been seen successfully hunting, so they were not just immature hunting attempts. Void hunting included oblique dives toward the ground that were aborted before touching the surface, in contrast to the vertical dives used in hunting. On other occasions fledglings 'parachuted' toward the ground by dropping gently with wings held high above their backs and varying the angle of wings and tail to control speed. This behavior was also observed in hunting adults when they were approaching prey, but fledglings performed it very high in the air (so they could not be hunting) or when approaching a perch (something never observed in adults). Void hunting was recorded for the first time 3 d after fledging. Void hunting attempts were observed in 13 different instances in five of the 10 fledglings.

Behaviors here considered to be development of hunting behavior included: (1) *Searching from a perch.* Fledglings were observed watching attentively the ground or the horizon, frequently making characteristic head movements that easily distinguished it from resting behavior. This behavior probably combined both paying attention to prey movements on the ground and to other family members hunting nearby. It was recorded for the first time 3 d after fledging. It was observed in 17 different instances and in all the 10 fledglings. (2) *Hunting on the wing.* I considered as such any behavior performed on the wing related to prey searching or prey capture similar to those performed by hunting adults (e.g., hovering flights while watching the ground followed by vertical dives). Hunting attempts were recorded for the first time 14 d after fledging and in a total of 74 different instances. They were observed in six of the 10 fledglings. Eight captures of small mammals by fledglings were observed before fledglings had achieved independence. The first prey capture was observed 29 d after fledging. Also, one fledgling was observed unsuccessfully trying to capture a Little Bustard (*Tetrax tetrax*), which is too big a prey for the kite.

Mendelsohn (1981) also observed that Black-shouldered Kite fledglings hunted before indepen-

dence. He recorded the first prey capture 12 d after fledging, but he did not record any play behaviors.

The time fledglings spent hunting in pair 1 increased gradually during the post-fledging, at the same time that the male decreased the time he spent hunting and reduced the number of prey given to the young (Fig. 6).

Many fledgling behaviors suggest the importance of perfecting flying and hunting skills before independence in the Black-shouldered Kite. Even chases between siblings and chases of other raptors could be interpreted in this way, rather than as competition between siblings (siblings never disputed prey) or incipient nest defense behavior (the raptors chased were not the species chased by the adults). Fledglings were able to hunt the habitual prey of the adults (small mammals) before independence, but never hunted insects which are usually the first prey of many species of raptors after fledging (Newton 1979, Bustamante 1990).

In conclusion, the observations of the post-fledging of the Black-shouldered Kite agree with the hypothesis that gradual development of hunting skills before independence is important in species hunting prey difficult to catch, while it is uncommon in species with generalized feeding habits (e.g., *Milvus* kites; Bustamante and Hiraldo 1989, Bustamante in press).

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